Special Publication No. 05-02

Bristol Bay Salmon, A Program Review

by

John H. Clark

January 2005

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

SPECIAL PUBLICATION NO. 05-02

BRISTOL BAY SALMON, A PROGRAM REVIEW

by

John H. Clark,
Alaska Department of Fish and Game,
Division of Commercial Fisheries
Juneau

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

January 2005

The Division of Sport Fish Fishery Management Reports series was established in 1989 for the publication of an overview of Division of Sport Fish management activities and goals in a specific geographic area. Since 2004, the Division of Commercial Fisheries has also used the Fishery Management Report series. Fishery Management Reports are intended for fishery and other technical professionals, as well as lay persons. Fishery Management Reports are available through the Alaska State Library and on the Internet: http://www.sf.ADF&G.state.ak.us/statewide/divreports/html/intersearch.cfm. This publication has undergone regional peer review.

John H. Clark,
Alaska Department of Fish and Game, Division of Commercial Fish,
1255 W. 8th St., P.O. Box 25526, Juneau, AK 99802-5526

This document should be cited as:
Clark, J. H. 2005. Bristol Bay Salmon, A Program Review. Alaska Department of Fish and Game, Special Publication No. 05-02, Anchorage.

TABLE OF CONTENTS

Page

LIST OF TABLES ii
ABSTRACT 1
INTRODUCTION 1
MANAGEMENT BASIS 1
STOCK ASSESSMENT DATA USES 4
HARVEST OBJECTIVES ESTABLISHED IN THE EARLY 1980S FOR BRISTOL BAY SALMON 6
EARLY 1980S STOCK ASSESSMENT PROGRAM AND COSTS 8
FY 05 BUDGET REQUEST FOR BRISTOL BAY SALMON 10
BASIC PROGRAM FOR BRISTOL BAY SALMON MANAGEMENT 14
ADDITIONAL PROGRAM NEEDS FOR BRISTOL BAY SALMON MANAGEMENT 16

LIST OF TABLES

Table		Page
1.	Bristol Bay salmon and Alaska salmon commercial fishery statistics.	2
2.	Stock assessment activities in Bristol Bay and uses of the information derived from these activities.	6
3.	Short-term and long-term harvest objectives (listed in thousands of fish) set for Bristol Bay salmon by the Alaska Department of Fish and Game in the early 1980s.	7
4.	A comparison of harvest objectives (listed in thousands of fish) defined for Bristol Bay salmon in the early 1980s with average harvest levels achieved since that time.	7
5.	Projects funded in the Commercial Fisheries Division in FY 83 for management of Bristol Bay salmon.	9
6.	Commercial Fisheries Division FY 05 Governors budget request for management of Bristol Bay salmon.	10
7.	Comparison of annual exvessel values for several western Alaska salmon fisheries and the percent each represented of the total annual Alaska salmon exvessel values for the years 1980–2003.	12
8.	Comparisons of General Fund operational budgets used by the Division of Commercial Fisheries of the Alaska Department of Fish and Game for management of four western Alaska salmon fisheries in FY 83 and requested for FY 05, average annual exvessel values for those salmon fisheries from 1980–1989, 2000–2003, and 1980–2003, and the consequent direct area level management investment by the State of Alaska expressed as pennies of General Fund operational costs per dollar of fishery exvessel value.	13
9.	Basic program needed by the Commercial Fisheries Division in FY 05 dollars to adequately manage Bristol Bay salmon.	15

ABSTRACT

A review of the Commercial Fisheries Division salmon management program in Bristol Bay was conducted. Stock assessment activities are discussed and grouped under three general types: those that provide information for pre-season forecasts, those that contribute to in-season management, and those that contribute to post-season assessments. The review included a summary of historical salmon catches and comparison of catches over the past 20 years with harvest objectives set in the early 1980s. The stock assessment activities implemented in the early 1980s were compared with activities planned for FY 05. Costs involved with these activities during both time frames are contrasted. Recommendations for changes in funding level of the Bristol Bay salmon program are made, including adding about $250,000 in general funds to the program in FY 05. Further improvements to the Bristol Bay stock assessment program are discussed along with potential approaches to implement these improvements.

Key words: Bristol Bay, salmon, stock assessment

INTRODUCTION

The Division of Commercial Fisheries of the Alaska Department of Fish and Game (ADF&G) manages the commercial and subsistence salmon fisheries in Bristol Bay with the goal of achieving and maintaining sustained production. Salmon management in Bristol Bay is primarily directed at sockeye salmon that are commercially harvested by gill net fishermen in the five discrete fishing districts of Bristol Bay: the Ugashik, Egegik, Naknek–Kvichak, Nushagak, and Togiak fishing districts. Chinook, chum, pink, and coho salmon are also harvested in Bristol Bay. Annual commercial harvests of salmon in Bristol Bay since Statehood have averaged about 16.5 million sockeye salmon, about 900 thousand chum salmon, about 500 thousand pink salmon, about 100 thousand Chinook salmon, and about 100,000 coho salmon. Total salmon harvests have averaged over 18 million fish since 1959 ranging from a low of about 1.5 million salmon in 1973 to a high in 1995 of about 45 million salmon (Table 1). The Bristol Bay commercial harvest of sockeye salmon since 1959 has represented about 56% of the statewide commercial harvest of that species, ranging from a low of 17% in 1973 to a high of 81% in 1965 (Table 1). Clearly, the Bristol Bay salmon fishery is one of the most important commercial salmon fisheries in the State of Alaska, and indeed in the world.

MANAGEMENT BASIS

Commercial salmon fisheries in Bristol Bay are managed strictly on an emergency order basis from late June through mid-July with the intent to achieve escapement objectives in key river systems that produce large annual runs of sockeye salmon including the Ugashik, Egegik, Naknek, Branch, Kvichak, Igushik, Wood, Nushagak, Nuyakuk, and Togiak rivers. Chum salmon run timing is coincident with sockeye salmon run timing and as a result, fishery management for both species is largely coincident. Chinook salmon run timing is earlier and as a result, early season fishery management decisions relative to time and area openings of the commercial fishery are often based upon status of Chinook salmon runs, particularly in the Nushagak District. Pink and coho salmon run timing is typically later than is the case for sockeye salmon, and as a result time/area openings for the commercial fishery in the later parts of the summer are often based upon status of pink and coho salmon runs rather than the status of sockeye salmon runs. The fishing districts, sub-districts, and fishery management strategies are designed to be as species and stock specific as is practical.

Table 1.–Bristol Bay salmon and Alaska salmon commercial fishery statistics.

Year	Bristol Bay Sockeye Commercial Harvest	Bristol Bay Chinook Commercial Harvest	Bristol Bay Chum Commercial Harvest	Bristol Bay Pink Commercial Harvest	Bristol Bay Coho Commercial Harvest	Bristol Bay Total Commercial Salmon Harvest	Alaska Sockeye Commercial Harvest
1959	4,608,000	84,289	481,516	301	17,335	5,191,441	8,077,000
1960	13,705,000	111,703	1,315,957	302,032	16,140	15,450,832	17,834,000
1961	11,913,000	88,656	727,932	538	20,633	12,750,759	16,081,000
1962	4,718,000	84,047	677,545	913,934	39,284	6,432,810	9,297,000
1963	2,871,000	62,269	370,097	461	41,262	3,345,089	6,215,000
1964	5,596,000	139,536	802,508	1,549,569	36,563	8,124,176	9,966,000
1965	24,255,000	112,967	360,544	700	8,083	24,737,294	29,770,000
1966	9,314,000	77,472	343,212	2,492,581	33,942	12,261,207	15,073,000
1967	4,330,000	117,193	476,357	1,114	53,796	4,978,460	8,576,000
1968	2,792,000	103,000	363,000	1,935,000	93,000	5,286,000	8,130,000
1969	6,617,000	124,911	332,520	1,870	81,326	7,157,627	11,417,000
1970	20,715,000	141,129	717,832	457,158	14,664	22,045,783	27,634,000
1971	9,584,000	123,015	676,906	212	12,709	10,396,842	14,180,000
1972	2,825,000	69,546	248,243	127,044	14,637	3,284,470	6,590,000
1973	761,000	44,044	684,278	387	57,035	1,546,744	4,490,000
1974	1,362,000	45,664	286,350	939,978	43,745	2,677,737	4,878,000
1975	4,899,000	29,991	324,113	422	46,281	5,299,807	7,453,000
1976	5,617,000	95,966	1,329,006	1,036,543	26,646	8,105,161	11,783,000
1977	4,878,000	130,526	1,598,164	4,517	107,215	6,718,422	12,460,000
1978	9,928,000	191,539	1,158,090	5,152,700	94,271	16,524,600	18,138,000
1979	20,737,000	207,317	799,638	3,427	73,572	21,820,954	28,723,000
1980	23,761,000	95,528	1,300,982	2,563,356	348,484	28,069,350	33,308,000
1981	25,603,000	237,304	1,504,828	7,280	313,705	27,666,117	36,343,000
1982	15,103,000	253,147	823,195	1,492,338	619,812	18,291,492	28,832,000
1983	37,372,000	198,609	1,632,181	484	128,101	39,331,375	52,874,000
1984	24,710,000	101,963	2,022,755	3,366,066	574,604	30,775,388	38,449,000
1985	23,703,000	120,441	1,068,461	457	162,822	25,055,181	38,983,000
1986	15,776,000	93,716	1,227,135	401,287	182,075	17,680,213	32,207,000
1987	16,069,000	75,399	1,529,142	57	65,403	17,739,001	35,430,000
1988	13,990,000	45,347	1,469,715	955,589	202,698	16,663,349	30,038,000
1989	28,735,000	39,760	1,258,808	438	239,834	30,273,840	44,117,000
1990	33,444,000	33,993	1,055,409	496,517	103,317	35,133,236	52,772,000
1991	25,821,000	30,440	1,289,749	305	117,740	27,259,234	44,646,000
1992	31,880,000	68,767	920,624	499,538	191,532	33,560,461	58,735,000
1993	40,463,000	85,858	838,382	413	72,729	41,460,382	64,717,000
1994	35,224,000	140,908	895,032	89,907	175,240	36,525,087	52,400,000
1995	44,269,000	99,388	979,880	471	49,444	45,398,183	63,530,000
1996	29,592,000	86,607	826,631	37,629	125,344	30,668,211	49,749,000
1997	12,310,000	76,838	317,606	110	50,463	12,755,017	31,087,000
1998	10,038,000	135,816	395,788	25,445	125,863	10,720,912	22,650,000
1999	25,660,000	26,929	685,329	71	19,559	26,391,888	44,679,000
2000	20,469,000	23,019	398,015	58,719	131,011	21,079,764	33,491,000
2001	14,181,000	24,666	831,949	428	17,084	15,055,127	26,524,000
2002	10,678,568	44,000	461,000	528	9,000	11,193,096	22,487,000
2003	15,277,000	47,940	933,031	244	43,255	16,301,470	30,907,000
Avg.	16,581,190	97,137	860,876	553,737	111,139	18,204,080	27,682,667
Min.	761,000	23,019	248,243	57	8,083	1,546,744	4,490,000
Max.	44,269,000	253,147	2,022,755	5,152,700	619,812	45,398,183	64,717,000

Table 1. –Continued.

Year	Percent of Total Alaska Commercial Sockeye Harvest in Bristol Bay	Bristol Bay Salmon Commercial Exvessel Value	Alaska Salmon Commercial Exvessel Value	Percent of Total Alaska Commercial Salmon Exvessel Value In Bristol Bay	Bristol Bay Commercial Permits Fished	Estimated Number of Bristol Bay Commercial Fishermen
1959	57%		$20,956,474			
1960	77%		$33,555,646			
1961	74%		$35,740,710			
1962	51%		$42,119,460			
1963	46%		$31,298,250			
1964	56%		$41,359,140			
1965	81%		$48,274,290		1,977	5,000
1966	62%		$54,201,954		2,264	5,700
1967	50%		$24,631,140		1,994	5,000
1968	34%		$49,455,412		1,730	4,300
1969	58%	$9,185,000	$42,427,856	22%	2,144	5,400
1970	75%	$25,468,000	$67,974,734	37%	2,297	5,700
1971	68%	$16,147,000	$51,411,428	31%	2,131	5,300
1972	43%	$4,832,000	$45,294,991	11%	1,957	4,900
1973	17%	$3,120,000	$60,058,839	5%	1,495	3,700
1974	28%	$6,015,000	$65,732,732	9%	873	2,200
1975	66%	$12,027,000	$56,728,622	21%	1,680	4,200
1976	48%	$21,948,000	$117,961,821	19%	1,854	4,600
1977	39%	$26,094,000	$170,813,920	15%	1,857	4,600
1978	55%	$52,272,000	$243,885,764	21%	2,231	5,600
1979	72%	$138,400,000	$341,426,077	41%	2,484	6,200
1980	71%	$84,302,000	$267,863,721	31%	2,571	6,400
1981	70%	$132,031,000	$397,362,556	33%	2,626	6,600
1982	52%	$80,665,000	$309,504,032	26%	2,651	6,700
1983	71%	$136,306,000	$320,184,190	43%	2,662	6,700
1984	64%	$106,365,000	$322,217,989	33%	2,673	6,700
1985	61%	$120,731,000	$371,496,815	32%	2,687	6,700
1986	49%	$141,063,000	$406,509,104	35%	2,692	6,700
1987	45%	$135,667,000	$499,454,252	27%	2,723	6,800
1988	47%	$176,858,000	$724,600,653	24%	2,759	6,900
1989	65%	$177,787,000	$582,798,094	31%	2,826	7,100
1990	63%	$202,259,000	$556,170,186	36%	2,840	7,100
1991	58%	$106,384,000	$325,075,232	33%	2,823	7,100
1992	54%	$193,745,000	$547,658,693	35%	2,847	7,100
1993	63%	$154,411,000	$414,150,488	37%	2,840	7,100
1994	67%	$140,905,000	$489,130,000	29%	2,804	7,100
1995	70%	$185,903,000	$486,950,000	38%	2,849	7,100
1996	59%	$140,872,000	$365,960,000	38%	2,825	7,100
1997	40%	$62,767,000	$296,720,000	21%	2,796	7,000
1998	44%	$64,887,000	$262,720,000	25%	2,759	6,900
1999	57%	$110,157,000	$383,330,000	29%	2,772	6,900
2000	61%	$81,119,000	$275,110,000	29%	2,744	6,900
2001	53%	$40,999,282	$229,180,000	18%	2,400	6,000
2002	47%	$32,049,444	$162,511,000	20%	1,863	4,700
2003	49%	$47,692,000	$198,924,000	24%	2,185	5,500
Avg.	56%	$90,612,364	$240,908,673	27%	2,389	5,982
Min.	17%	$3,120,000	$20,956,474	5%	873	2,200
Max.	81%	$202,259,000	$724,600,653	43%	2,849	7,100

STOCK ASSESSMENT DATA USE

Timely catch and escapement data is essential in the high volume and short-term sockeye salmon fishery that takes place from about mid-June through mid-July. Attaining escapement goals is achieved by emergency order adjustments of fishing time and area. Early in the fishing season, fishery management decisions are based upon pre-season forecasts of abundance. However, very quickly in the fishing season, stock assessment data that is collected in-season is used to update and supplant the pre-season forecast. In-season fishery management is dependent upon timely in-season run strength data and analysis by stock that is provided by a broad array of stock assessment projects. Such assessment efforts include: test fishing, catch analysis, run modeling, aerial surveys, sonar and tower counts of escapement, and age composition of catches and escapements. Rapid in-season analysis of such data provides the necessary management capability and response time to continuously adjust fishing time and area in order to attain escapement objectives for component spawning stocks of salmon while allowing commercial fishing opportunity at an adequate level to harvest salmon surplus to reproductive needs.

Total abundance by stock and age for major sockeye salmon runs that spawn in Bristol Bay river systems has been monitored by ADF&G since statehood using post-season analysis of documented catches, escapements, age compositions of catches and age compositions of escapements. Commercial catches, by fishing district and opening date, are monitored through the fish ticket system (sales receipts issued to commercial fishermen upon selling their catch to processors). Subsistence harvests are minor compared to commercial landings, but are monitored by ADF&G through a permit system. Sport harvests are also minor and are annually estimated by ADF&G through a postal survey. Escapements into major sockeye salmon producing river systems is annually monitored through a total enumeration program facilitated by towers erected along river banks from which migrating fish are counted on a ten minute per hour sub-sampling basis (Ugashik, Egegik, Naknek, Branch, Kvichak, Igushik, Wood, Nuyakuk, and Togiak rivers) or through sonar counts made in the lower Nushagak River. Both spawning escapements and harvests are sampled to estimate annual age, sex, and size composition. Age composition has historically been used to facilitate estimation of stock composition in the Naknek–Kvichak and Nushagak fishing districts where harvests are comprised of several sockeye salmon stocks. These stock and age specific catch and escapement data have been the basis for development of long-term brood tables used for both pre-season forecasting capability and for scientific estimation of escapement goals. These efforts have provided the basis for about a forty-year set of paired estimates of escapement and subsequent recruitment for the major stocks of sockeye salmon returning to Bristol Bay. The Bristol Bay sockeye salmon fishery is one of the very few major salmon fisheries in the world with a good quality, long-term, set of brood tables by stock.

While accuracy and precision of estimated annual catches, annual escapements, and annual age compositions of both escapements and catches is considered to be excellent on a post-season basis, the allocation methodology used to apportion sockeye salmon catches to component stocks in Bristol Bay represents but a coarse approximation of the actual catch by stock. A series of largely untested assumptions is used to allocate stock composition in some districts. For example, in the Ugashik District, biologists of the ADF&G make the assumption that all sockeye salmon caught in this fishing district are of Ugashik origin. While ADF&G biologists know that this assumption is violated, it is hoped that the biases associated with these types of assumptions are relatively small and to some extent balanced by similar assumptions in other fishing districts. In fishing districts with two or more major contributing stocks, age compositions of the communal catch and the separate spawning escapement populations is used to make stock allocation estimates under the assumption that harvest rate by age in the mixed stock fishing district is similar across all contributing stocks.

Sporadic efforts in the 1980s and 1990s were used to implement better fishery science to make catch allocations, but budget cuts and logistic and technical concerns with the methodology resulted in the situation where methods used over the last several years have reverted to historic methodologies. As a result, catch allocation methods have not improved in a substantive manner over those methods in use some 50 years ago. This is a technical area of the current stock assessment program that begs for improvement. Recent advances in DNA-based genetic stock

identification methodologies provide the potential to develop accurate and precise scientifically based stock composition estimates. Although more developmental work in this area is needed, such scientific methodology has the potential to make a substantial improvement in the current stock assessment program in Bristol Bay, provided that a stable long-term funding source can be identified. Both developmental research and stable funding are needed before this potential improvement can reach full fruition.

On a pre-season basis, ADF&G uses available data (brood table information) to predict likely returns of sockeye salmon to Bristol Bay by stock (***pre-season forecasts***). These analyses assume that past productive potential by stock and escapement level will be indicative of future production trends. These forecasts are helpful to industry and to fishery users in pre-season planning. Pre-season forecasts are also useful to ADF&G fishery managers during the early portions of the fishing season for determining time/area openings of the fishery.

Efforts that started in the 1960s and culminated in the late 1980s were made to enumerate smolt out-migrations (Ugashik, Egegik, Naknek, Kvichak, Wood, and Nuyakuk). Smolt production information was desired for two purposes: (1) improvement in forecasting ability by being able to model freshwater and oceanic life history phases separately; and (2) improvement in estimates of appropriate escapement goals by removing the effect of variable oceanic survival. Budgetary reductions starting in the 1990s led to the discontinuation of most of these efforts with the end result that extended time series of data are only available for a few systems. As a result, the improvements sought in the ability to better forecast and set escapement goals for Bristol Bay sockeye salmon based upon the smolt stock assessment efforts have now been lost for most of these river systems. In the case of the Kvichak stock of sockeye salmon, the stock with the longest set of smolt estimates, changes in site locations and other problems have resulted in a lack of trust of the derived smolt production estimates. Given that about half of all the sockeye salmon harvested in Alaska come from a handful of Bristol Bay river systems, this stock assessment area is one that begs for both technical improvements and a secure long-term funding source.

In-season information in Bristol Bay is used on a daily basis from mid-June through mid-July to update pre-season stock forecasts in an effort to better gauge run strengths and make appropriate decisions regarding openings and closures of the commercial fishery on a district and/or sub-district basis (***in-season management***). Much of the stock assessment program in place in Bristol Bay over the past 50 years was designed and is used to facilitate scientifically based fishery management on an in-season basis. These programs are very important and are the cornerstone for the successful fishery management practices that have sustained the runs while still allowing extensive commercial utilization of the sockeye salmon resource by the fishery industry. Improvements in this area of the stock assessment program can provide immediate benefits to dependent commercial salmon fishermen, the industry, and the economy of the State of Alaska. For example, a delay in the opening of a fishing district by as much as one day during the peak of the Bristol Bay salmon run can easily result in the lost opportunity for fishermen to harvest a million or more sockeye salmon worth as much as $3 million in exvessel value to the fishermen.

On a post-season basis, information is analyzed to update brood tables and to determine if management was adequate to the task of meeting escapement objectives by stock while still allowing fishing opportunity sufficient to harvest salmon surplus to escapement needs (**post-season assessment**). After the commercial fishery is over, staff biologists edit catch reports, make final catch allocations, complete the aging of all sampled fish, edit and review data collected from escapement counting sites and update the brood table data set. From an annual cycle basis, this is the last step in utilizing the extensive stock assessment data collections that occurred for the year.Stock assessment projects in Bristol Bay can be classified as to whether they contribute to pre-season forecasts, in-season management, or post-season assessment needs and such classification may be helpful to understanding stock assessment activities and data uses in Bristol Bay (Table 2).

Table 2.–Stock assessment activities in Bristol Bay and uses of the information derived from these activities.

Project/Activity	Pre-Season Forecasts	In-Season Management	Post-Season Assessment
Total Escapement Assessment *(Ugashik, Egegik, Naknek, Branch, Kvichak, Igushik, Wood, Nuyakuk, and Togiak Tower and Nushagak Sonar projects)*	Historic annual data used	Daily counts and cumulative counts used to estimate run timing and strength	Annual total data used
Escapement Age Composition *(Ugashik, Egegik, Naknek, Branch, Kvichak, Igushik, Wood, Nuyakuk, and Togiak Tower and Nushagak Sonar projects)*	Historical data used	Data used for assessment of pre-season forecast accuracy and for in-season assignment of catch to stock of origin	Data used for brood tables and for catch allocations
Inside Test Fishing *(Ugashik, Egegik, Naknek–Kvichak, and Igushik test fish projects)* and in-season aerial surveys of lower rivers	Not used	Used to estimate number of fish above district but below tower	Not used
Outside Test Fishing *(Port Moller)*	Not used	Used to estimate number of fish that have not yet reached Bristol Bay	Not used
Catch Data (fish tickets) *(Ugashik, Egegik, Naknek–Kvichak, Nushagak, and Togiak fishing districts)*	Historic Annual data used	Used to estimate run timing and strength by district	Annual total data used
Catch Age Composition *(Ugashik, Egegik, Naknek–Kvichak, Nushagak, and Togiak fishing districts)*	Historical data used	Data used for assessment of pre-season forecast accuracy and for in-season assignment of catch to stock of origin	Data used for brood tables and for catch allocations
Smolt Enumeration *(Kvichak, Naknek, Egegik, Ugashik, Wood, and Nuyakuk)*	Historic annual data used at times	Not used	Not used, but have potential for escapement goals

From a fishery management perspective, the most important stock assessment activities and data sets can be rated by priority as: (1) most important—in-season management related activities, (2) second most important—post-season assessment related activities; and (3) third most important—pre-season forecast related activities. Many stock assessment activities and data sets are used one way or another for all three categories such as basic escapement data. But some projects, like test fish projects are only utilized for in-season management.

HARVEST OBJECTIVES ESTABLISHED IN THE EARLY 1980S FOR BRISTOL BAY SALMON

Many of the basic elements of the Bristol Bay stock assessment program were put in place in the late 1950s and early 1960s. Salmon harvests in the first couple of decades after Statehood were substantially less than historic catch data indicated was sustainable in the long-term. Poor survival conditions in the 1970s further depressed Bristol

Bay salmon production even though many of the required program elements for scientific fishery management were in place by then. Long-term sustainability was determined by evaluating annual catch data available since inception of the Bristol Bay fishery in the late 1800's. These catch data were analyzed to determine the highest average harvest that occurred over a thirty year period, roughly the length of time associated with six generations of sockeye salmon, five generations for Chinook salmon, seven generations for chum and coho salmon and fifteen generations for pink salmon. In the late 1970s and early 1980s, ADF&G invested additional funding short-term and long-term harvest objectives. Harvest objectives developed for Bristol Bay salmon were based upon both observed long-term catch information and an evaluation of the current (early 1980s) stock assessment program. Information provided in Table 3 is taken from a planning document printed and provided to the Alaska Legislature in 1982. As can be seen, the long-term harvest objective for Bristol Bay salmon was defined in the early 1980's as about 18.6 million salmon per year.

Table 3.–Short-term and long-term harvest objectives (listed in thousands of fish) set for Bristol Bay salmon by the Alaska Department of Fish and Game in the early 1980s.

Species	30-Year Highest Harvest	1951–1960 Average Harvest	1961–1970 Average Harvest	1971–1980 Average Harvest	Short-term Harvest Objectives [a]	Long-term Harvest Objectives [b]
Sockeye	15,877.0	6,736.2	9,313.5	8,550.3	12,000.0	15,000.0
Chum	622.6	413.7	517.3	804.8	750.0	750.0
Pink	627.9	164.7	735.4	982.9	1,500.0	2,500.0
Coho	111.8	39.8	42.3	104.6	175.0	250.0
Chinook	105.0	72.4	105.1	104.3	100.0	100.0
Total	16,744.8	7,426.8	10,713.5	10,547.0	14,500.0	18,600.0

[a] Based upon average survival conditions, current level of funding and present management technology.

[b] Based upon average survival conditions and increased level of funding and technological abilities for fishery management.

It is informative to compare the harvest objectives that were established in the early 1980s with average harvests since that time (Table 4). Informative, because salmon harvests in Bristol Bay during the period of 1950–1980 were far below indicated sustainable levels and far below the harvest objectives that were set in the early 1980s—at a time when the State of Alaska invested significant additional funding into the stock assessment program in conjunction with the goal setting that had taken place. Informative too, as this is one way of providing some evaluation of whether or not these funding investments provided substantial changes in catch levels that occurred after that time frame.

Most of the additional funding invested in the Bristol Bay program in the late 1970s and 1980s was used by the ADF&G in either the in-season or pre-season stock assessment programs for sockeye salmon, and Table 4 demonstrates the impacts of these investments.

Table 4.– A comparison of harvest objectives (listed in thousands of fish) defined for Bristol Bay salmon in the early 1980s with average harvest levels achieved since that time.

Species	Historical 30-Year Highest Harvest	1981–1990 Average Harvest	1991–2000 Average Harvest	1981–2003 Average Harvest	Short-term Harvest Objectives	Long-term Harvest Objectives
Sockeye	15,877	23,450	27,573	23,929	12,000	15,000
Chum	622	1,359	755	1,016	750	750
Pink	627	672	71	323	1,500	2,500
Coho	111	259	106	162	175	250
Chinook	105	120	77	91	100	100
Total	16,744	25,861	28,582	15,521	14,500	18,600

Sockeye salmon production since 1980 has averaged almost 24 million fish over a 23-year period (four plus generations of sockeye salmon), or roughly 8 million more than the historical 30-year high observed prior to that time or about a 50% increase over what was believed in early 1980s to be the long term sustainable high level for Bristol Bay sockeye salmon. These post-1980 sockeye salmon harvests have about doubled the short-term harvest objectives set in the early 1980s and have exceeded the long-term harvest objectives by about 9 million fish or again, by about 50%. This demonstrates phenomenal fishery management success.

While other factors are also involved with the increase in production of Bristol Bay sockeye salmon since the 1970s, there is no doubt that the stock assessment program funded for the Bristol Bay salmon fishery by the early to mid-1980s led to significant improvements in management capability and that those improvements directly resulted in greatly increased long-term harvest opportunity for the commercial salmon industry that has generated millions of dollars of economy to the local Bristol Bay area and to the State of Alaska in general. Statistics for the co-mingled chum salmon stocks of Bristol Bay demonstrate that production since 1980 has increased over historic levels and has largely been on or above target with objectives set some 20 years ago. Coho salmon production since 1980 is better than historic levels, but has not been sustained at objective levels; market conditions may be partially responsible. Commercial Chinook salmon production (shown above) has been maintained at about historic levels while sport fisheries for Chinook in Bristol Bay have expanded over the past couple of decades. Pink salmon production since 1980 has been less than historic levels and well below objectives established for the species in the early 1980s, primarily due to market conditions and low price. In general, the data demonstrate a significant improvement in sockeye production coincident with increased funding for stock assessment abilities, harvest at about historic levels for chum, coho, and Chinook, species for which little additional stock assessment was developed and maintained through time since the objectives were established, and decreased production for pink salmon, a species with little current value and market interest in Bristol Bay.

EARLY 1980s STOCK ASSESSMENT PROGRAM AND COSTS

The FY 82 Bristol Bay salmon fishery management operational budget allocation totaled $1,195,300. This allocation was comprised of $50,000 in test fish funds to support a portion of the costs of the test fishing projects that were implemented, $40,000 in Federal funds to support a portion of the pre-season forecasting activities, and $1,105,300 in State of Alaska General Funds that were used to support all remaining fishery management costs (Table 5).

As the 1980s proceeded into the early to mid 1990s, the level of budget support for Bristol Bay salmon management continued to increase. A few additional projects and activities were added, a few activities were terminated and monies to cover inflation was added to base funding support for existing projects and activities. While on a project basis, budget support varied across the years, the level of overall program remained about the same or improved somewhat with most of the basic program elements such as catch and escapement enumeration and sampling being funded and implemented each year and with various research efforts moving from topic to topic as needed. The number of permanent staff positions moved up and down a bit, but overall remained about the same. However, by the mid-1990s, significant budget cuts started eating away significantly at the level of fiscal support allocated for management of Bristol Bay salmon. The FY 82 General Fund budget if expressed in FY 05 dollars adjusted for inflation would be double or more the level of about $1.2 million used in FY 82.

Table 5.–Projects funded in the Commercial Fisheries Division in FY 83 for management of Bristol Bay salmon.

Project/Activity	Funding Level and Source	Comments/Explanations/Timelines
Escapement Enumeration	$143,600 – G.F.	Escapement sampling and counts or aerial surveys, in Ugashik, Egegik, Naknek, Branch, Kvichak, Wood, Igushik, Nuyakuk, and Togiak Rivers; activities in place since the late 1950s.
Nushagak Sonar	$67,900 – G.F.	Escapement estimation and sampling in Nushagak River; project first implemented in about 1980.
Inside Test Fishing	$55,700 – G.F.	Kvichak, Egegik, Ugashik, and Igushik Rivers; activities in place since the 1960s except for Igushik developed in late 1970s.
Catch Sampling	$26,900 – G.F.	Ugashik Egegik, Naknek–Kvichak, Nushagak, and Togiak fishing districts; activities in place since 1950s.
Port Moller Offshore	$78,300 – G.F.	Test Fishing; program fully developed in late 1970s.
Sockeye Forecast	$32,600 – G.F.	Ongoing activity since 1960s.
Pink Forecast	$12,500 – G.F & $2,500 – Fed	New activity being developed in early 1980s.
Catch & Escapement Leaflet	$11,000 – G.F. & $5,000 – Fed	Post-Season Report; activity in place since 1960s.
Nushagak Chinook Research	$51,200 – G.F.	New activity intended to improve Nushagak Chinook data base.
Stock Separation	$3,200 – G.F.	New research to improve catch allocations of sockeye in early 1980s.
District Test Fishing	$50,000 – Test Fish Fund	Test fishing in districts during closed periods to estimate strength of run, activity in place since 1960s.
Smolt Studies	$101,200 – G.F.	Smolt enumeration in the Wood, Nuyakuk, Kvichak, Naknek, Egegik, and Ugashik rivers; new work with sonar starting in late 1970s.
General Salmon Management	$121,000 – G.F.	Aerial surveys for management, subsistence and commercial fishery monitoring and other misc. activities; activity in place since 1960s.
Program Management	$73,900 – G.F.	Office telephone, rent, heat, electricity, etc. costs, vehicle charges, and maintenance charges; activity in place since 1960s.
Permanent Staff Costs	$296,300 – G.F. $32,500 – Fed	Line 100 costs for three FB III positions, four FB II positions and one CT II position; four of the PFT positions were first established in the mid-1970s.
TOTAL	$1,195,300	All Funding Sources

FY 05 BUDGET REQUEST FOR BRISTOL BAY SALMON

The Division of Commercial Fisheries requested, through the Governors budget, a total of $1,245,400 in general funds and $472,900 in test fish funds for management of Bristol Bay salmon fisheries in FY 05 (Table 6). The budget allocation in FY 83, some twenty years previous, was about the same in terms of general funds, while the allocation of test fish funds has increased almost ten-fold.

The large increase in test fish funding in Bristol Bay is because of a change in policy since the early 1980s in terms of how test fish funding could be used by ADF&G. In the early 1980s, policy was that test fish funds could only be used for boat charter costs when the Department needed to utilize a commercial fishing boat to fish and thereby gauge the strength of the salmon runs. Salmon caught while test fishing were sold and those sales were used to pay for the boat charter.

Rules used for use of test fish funding have changed. For instance, Table 6 documents the request to use test fish funds for enumeration of Ugashik River smolt, a stock assessment activity that has absolutely nothing to do with test fishing. As general fund budget reductions have been implemented over the past decade or so, test fish funding has been used to continue project activities associated with Bristol Bay salmon stock assessment that otherwise would have had to be eliminated, and that is the positive side of this change in policy.

Table 6.–Commercial Fisheries Division FY 05 Governors budget request for management of Bristol Bay salmon.

Project/Activity	Funding Level Request	Funding Source
Kvichak Tower	$32,900	G.F.
Naknek Tower	$36,400	G.F.
Egegik Tower	$33,600	G.F.
Ugashik Tower	$32,000	G.F.
Wood Tower	$28,000	G.F.
Nushagak Sonar	$91,300	G.F.
Igushik Tower	$32,600	G.F.
Togiak Tower	$31,700	G.F.
Bristol Bay Research	$156,100	G.F.
Catch Sampling	$57,000	Test Fish Fund
Kvichak Test Fish	$35,300	Test Fish Fund
Egegik Test Fish	$35,700	Test Fish Fund
Ugashik Test Fish	$30,400	Test Fish Fund
Igushik Test Fish	$24,500	Test Fish Fund
Outside Test Fishing	$145,100	Test Fish Fund
Eastside District Test Fish	$41,300	Test Fish Fund
Nushagak District Test Fish	$51.900	Test Fish Fund
Ugashik Smolt Test Fish	$21,900	Test Fish Fund
Port Moller Test Fish	$30,000	Test Fish Fund
Fishery Monitoring, Eastside	$99,700	G.F.
Fishery Monitoring, Westside	$53,400	G.F.
Program Management, Eastside	$258,600	G.F.
Program Management, Westside	$359,300	G.F.
TOTAL: General Fund	$1,245,400	G.F.
TOTAL: Test Fish Fund	$472,900	Test Fish Fund
TOTAL: ALL FUNDING	$1,718,300	ALL

Many important and essential stock assessment activities have been maintained in this fashion. In the current fiscal climate where many mainline stock assessment activities have been funded through the test fish program, substantial numbers of salmon have to be harvested through a cost recovery fishery simply to keep a positive balance in the test fish account. As a result, ADF&G issues contracts to have commercial fishermen harvest large numbers of fish simply in an effort to keep important stock assessment activities in place. This effort detracts from the fishery manager's important function of managing one of the world's most important commercial salmon fisheries. These fish, if not harvested by the State, could be harvested by the public, and that is the negative side of this change in policy. Hence in FY 05, under the Governors budget request, fishery managers would have to implement a program of commercial fishing by the State to harvest $472,900 worth of salmon that otherwise could be caught by the public. Placing the State fishery managers in a competitive situation with the public they directly regulate in order to fund its direct fishery management function is awkward.

Current implementation of the very significant level of commercial salmon fishing for cost recovery by the State in Bristol Bay in and of itself costs significant monies. Like other business ventures, it costs money (in this case test fish funds) to make money (test fish funds), which in this case is used to support other fishery management functions. A substantial portion of the outside test fish budget is for this purpose.

Policy decision makers need to be careful and prudent concerning the level of program authorized in Bristol Bay for funding with test fish funds. My recommendation after review of the Bristol Bay program is that test fish fund usage in the Bristol Bay salmon management program should be confined to test fish projects that are used for in-season management. If this recommendation were to be implemented, the test fish fund expenditures associated with Bristol Bay management would be substantially decreased (by more than half). Fish currently harvested by the State could then be harvested directly by fishermen, adding to the economic benefits from the fishery. However, if such a recommendation were acted upon, replacement funding for some of the activities currently funded with test fish funds, such as the catch sampling program, would have to be obtained.

The FY 05 Commercial Fishery Division request of $1,245,400 of general funds for management of the Bristol Bay salmon fishery represents a mere 4% increase from the level of general funds used for management of this fishery in FY 83, some twenty years ago. Given inflation alone, this clearly represents a substantial decrease in the level of program that can be implemented with general funds.

A summary of four salmon fisheries in Western Alaska was developed for comparative purposes wherein exvessel value of the four commercial fisheries was documented for the years 1980–2003 along with the percent each represented of the total Alaska salmon exvessel value (Table 7). These data give an indication of the relative importance of these salmon fisheries to the economy of the State of Alaska. However, in each of these four areas, the salmon runs also support important subsistence and sport fisheries. I had no easy method with which to capture the economic importance of the subsistence and sport fisheries. These data indicate that since 1980, the Bristol Bay salmon fishery was responsible for about 30% of the Alaskan salmon exvessel value, while the Kuskokwim salmon fishery was responsible for about 1%, the Yukon salmon fishery was responsible for about 1.5%, and the Norton Sound salmon fishery was responsible for about one tenth of 1% (Table 7).

Table 7.–Comparison of annual exvessel values for several western Alaska salmon fisheries and the percent each represented of the total annual Alaska salmon exvessel values for the years 1980–2003.

Year	AK Exvessel	BB Exvessel	BB %	Kusk. Exvessel	Kusk. %	Yukon Exvessel	Yukon %	N. Sd. Exvessel	N. Sd %
1980	$267,863,721	$ 84,302,000	31.5%	$ 2,725,134	1.0%	$ 5,177,754	1.9%	$ 572,125	0.2%
1981	$397,362,556	$132,031,000	33.2%	$ 3,766,525	0.9%	$ 8,068,103	2.0%	$ 761,658	0.2%
1982	$309,504,032	$ 80,665,000	26.1%	$ 4,213,954	1.4%	$ 5,621,378	1.8%	$1,069,723	0.3%
1983	$320,184,190	$136,306,000	42.6%	$ 2,670,400	0.8%	$ 6,215,299	1.9%	$ 946,232	0.3%
1984	$322,217,989	$106,365,000	33.0%	$ 5,809,000	1.8%	$ 4,922,975	1.5%	$ 738,064	0.2%
1985	$371,496,815	$120,731,000	32.5%	$ 3,248,089	0.9%	$ 6,033,577	1.6%	$ 818,477	0.2%
1986	$406,509,104	$141,063,000	34.7%	$ 4,746,089	1.2%	$ 5,618,987	1.4%	$ 546,452	0.1%
1987	$499,454,252	$135,667,000	27.2%	$ 6,392,822	1.3%	$ 7,202,358	1.4%	$ 517,894	0.1%
1988	$724,600,653	$176,858,000	24.4%	$12,514,489	1.7%	$ 11,821,175	1.6%	$ 760,641	0.1%
1989	$582,798,094	$177,787,000	30.5%	$ 5,171,860	0.9%	$ 8,884,695	1.5%	$ 319,489	0.1%
1990	$556,170,186	$202,259,000	36.4%	$ 4,894,580	0.9%	$ 5,930,336	1.1%	$ 474,064	0.1%
1991	$325,075,232	$106,384,000	32.7%	$ 3,971,423	1.2%	$ 8,634,917	2.7%	$ 413,479	0.1%
1992	$547,658,693	$193,745,000	35.4%	$ 5,295,912	1.0%	$ 11,258,181	2.1%	$ 463,616	0.1%
1993	$414,150,488	$154,411,000	37.3%	$ 3,962,890	1.0%	$ 5,427,794	1.3%	$ 368,723	0.1%
1994	$489,130,000	$140,905,000	28.8%	$ 5,201,611	1.1%	$ 4,769,431	1.0%	$ 863,060	0.2%
1995	$486,950,000	$185,903,000	38.2%	$ 4,209,752	0.9%	$ 6,706,487	1.4%	$ 356,164	0.1%
1996	$365,960,000	$140,872,000	38.5%	$ 2,900,603	0.8%	$ 4,594,161	1.3%	$ 292,264	0.1%
1997	$296,720,000	$ 62,767,000	21.2%	$ 1,058,808	0.4%	$ 5,714,487	1.9%	$ 326,618	0.1%
1998	$262,720,000	$ 64,887,000	24.7%	$ 1,634,495	0.6%	$ 1,955,891	0.7%	$ 351,410	0.1%
1999	$383,330,000	$110,157,000	28.7%	$ 551,725	0.1%	$ 5,046,403	1.3%	$ 82,638	0.0%
2000	$275,110,000	$ 81,119,000	29.5%	$ 1,197,149	0.4%	$ 734,239	0.3%	$ 143,621	0.1%
2001	$229,180,000	$ 40,999,282	17.9%	$ 749,916	0.3%	-	0.0%	$ 56,921	0.0%
2002	$162,511,000	$ 32,049,444	19.7%	$ 322,679	0.2%	$ 1,722,367	1.1%	$ 2,941	0.0%
2003	$198,924,000	$ 47,692,000	24.0%	$ 882,701	0.4%	$ 1,920,623	1.0%	$ 64,473	0.0%
1980s Avg.	$420,199,141	$129,177,500	30.7%	$ 5,125,836	1.2%	$ 6,956,630	1.7%	$ 705,076	0.2%
1990s Avg.	$412,786,460	$136,229,000	33.0%	$ 3,368,180	0.8%	$ 6,003,809	1.5%	$ 399,204	0.1%
00–03 Avg.	$216,431,250	$ 50,464,932	23.3%	$ 788,111	0.4%	$ 1,094,307	0.5%	$ 66,989	0.0%
80–03 Avg.	$383,149,209	$118,996,864	30.4%	$ 3,670,525	0.9%	$ 5,582,567	1.4%	$ 471,281	0.1%

Note: AK = Total Alaska salmon, BB = Bristol Bay Salmon; Kusk. = Kuskokwim Salmon, Yukon = Yukon salmon, and N. Sd. = Norton Sound salmon.

In other words, from a comparative standpoint, the direct economic benefits as measured through exvessel value of the Bristol Bay salmon commercial fishery over the past 24 years was about 30-fold that of the Kuskokwim commercial salmon fishery, about 20-fold that of the Yukon commercial fishery, and about 300-fold that of the Norton Sound commercial salmon fishery. Another comparison was developed; specifically, general fund budget allocations for management of these four salmon fisheries, both historically and as requested through the FY 05 Governors budget request (Table 8). A comparison of the general fund allocation used by Commercial Fisheries Division in FY 83 to the FY 05 Governors request reveals an increase of about $6.2 million or a 37% increase (Table 8). The same comparison for Bristol Bay salmon is an increase of only $50,100 or 4%, while for the other three western Alaska salmon fisheries the increases were: (1) Kuskokwim salmon, an increase of $556,700 or 122%, (2) Yukon salmon, an increase of $243,700 or 31%, and (3) Norton Sound salmon, an increase of $390,900 or 123% (Table 8).

Table 8.–Comparisons of General Fund operational budgets used by the Division of Commercial Fisheries of the Alaska Department of Fish and Game for management of four western Alaska salmon fisheries in FY 83 and requested for FY 05, average annual exvessel values for those salmon fisheries from 1980–1989, 2000–2003, and 1980–2003, and the consequent direct area level management investment by the State of Alaska expressed as pennies of General Fund operational costs per dollar of fishery exvessel value.

Category	Total Commercial Fisheries	Bristol Bay Salmon	Kuskokwim Salmon	Yukon Salmon	Norton Sound Salmon
Historic: FY 83 Allocation & Average Exvessel Values from 1980–1989					
FY 83 Gen. Fund Budget	$16,890,000	$1,195,500	$455,000	$776,300	$317,500
% Gen. Fund Budget		7.1%	2.7%	4.6%	1.9%
Average Exvessel Value	$420,199,141	$129,177,500	$5,125,836	$6,956,630	$705,076
Pennies per $ Exvessel Value		1 cent	9 cents	11 cents	45 cents
Current: FY 05 Request & Average Exvessel Values from 2000–2003					
FY 05 Gen. Fund Request	$23,086,300	$1,245,600	$1,011,700	$1,020,000	$708,400
% Gen. Fund Budget		5.4%	4.4%	4.4%	3.1%
Average Exvessel Value	$216,431,250	$50,464,932	$788,111	$1,094,307	$66,989
Pennies per $ Exvessel Value		2 cents	128 cents	93 cents	1,057 cents
Comparison of Change from FY 83 Allocation to FY 05 Request					
Change from FY 83 to FY 05	$6,196,300	$50,100	$556,700	$243,700	$390,900
% Change	37%	4%	122%	31%	123%
Overall: FY 05 Request & Long-term Average Exvessel Values from 1980–2003					
FY 05 Gen. Fund Request	$23,086,300	$1,245,600	$1,011,700	$1,020,000	$708,400
Average Exvessel Value	$383,149,209	$118,996,864	$3,670,525	$5,582,567	$471,281
Current Pennies per Long-Term Average Annual $'s of Exvessel Value		1 cent	28 cents	18 cents	150 cents

Note: The FY 83 budget of $16,890,000 was total general funds for the Division, not just for salmon and the FY 05 request is for total Division general fund operations, not just for salmon.

Actual level of total funding currently used by the Commercial Fisheries Division and planned for in FY 05 in the three non-Bristol Bay Western Alaska salmon fisheries included in Table 8 is actually substantially more than indicated in Table 8 because of the availability of Federal contract monies to ADF&G that total several million dollars. Hence, a total budget comparison would be even more striking in terms of the relatively small increases in funding for Bristol Bay salmon across the twenty or so year period, as compared to the very large increases in funding for the other three Western Alaska salmon fisheries. Funding request materials provided to the Alaska Legislature by the Division of Commercial Fisheries in the 1980s included an analysis wherein the budget level under request was divided by the average exvessel value of the fishery for which funds were being requested. The request material was presented in this format in order to provide policy decision makers with a measure of the State of Alaska "***investment***" being made to manage commercial fisheries. Table 8 includes these types of comparisons and as can be seen, general fund investments expressed as pennies per dollar of fishery exvessel value in the 1980s ranged from 1 cent for the Bristol Bay salmon fishery to 45 cents for the Norton Sound salmon fishery. Current comparisons range from 2 cents for the Bristol

Bay fishery to 1,057 cents for the Norton Sound salmon fishery. Current investments divided by long-term average exvessel values range from 1 cent for the Bristol Bay salmon fishery to 28 cents for the Kuskokwim salmon fishery to 18 cents for the Yukon salmon fishery to 150 cents for the Norton Sound salmon fishery (Table 8).

The data provided in Tables 7 and 8 make one of several compelling arguments for the case of increasing the amount of general funds allocated for management of the Bristol Bay salmon fishery well beyond the current levels being requested. Quite simply put, the Bristol Bay salmon fishery is a large, very important commercial fishery that supports a major job producing industry in the State of Alaska, yet general funds allocated for management of that fishery are out of synchrony with historical funding patterns: only a 4% increase has occurred over a twenty year or so span of time while other Western Alaska salmon fisheries with minor exvessel values have been provided with significant increases in funding. And, past performance has demonstrated that investment in this fishery stock assessment and management program has paid huge dividends in terms of harvest and subsequent economic benefits in a rural portion of Alaska.

BASIC PROGRAM FOR BRISTOL BAY SALMON MANAGEMENT

Earlier in this document, various elements of the salmon stock assessment program in Bristol Bay were discussed and project/activities were described in terms of how they contribute to the pre-season, in-season, and/or post-season aspects of management in Bristol Bay. Many of the very basic stock assessment projects are such that they need to be operated on an annual basis, regardless of Divisional funding crises, so long as the primary management basis in Bristol Bay remains in place. Quite simply, commercial salmon fisheries in Bristol Bay cannot be managed strictly on an emergency order basis from late-June through mid-July with the intent to achieve escapement objectives without these basic projects being in place. These are the very basic projects and cornerstones that provide the needed information concerning abundance and age composition of salmon that are caught or that escape to spawn in major salmon producing rivers of Bristol Bay. Further, without fishery biologists to conduct in-season management, without an infrastructure to support the management system, and without tools such as inside test fishing and aerial surveys, the management system as it has existed for the past five decades cannot continue. Unless the State of Alaska wants the Bristol Bay salmon fishery to revert to the types of salmon fishery management that occurred under Federal jurisdiction during the first half of the 20th century, a means to annually fund and maintain the very basic stock assessment program for salmon in Bristol Bay needs to occur.

Continuing the past decade practice of "*nickeling*" and "*diming*" general fund support for this very basic stock assessment program will cost the Bristol Bay commercial salmon industry hundreds of millions of dollars. Policy decision makers need to understand that this fishing industry with an average annual exvessel value of almost $100 million since Statehood is completely reliant upon fishery management by the Division of Commercial Fisheries and that this fishery management regime is data intensive. In my opinion, the very "basic" program (*no frills option*) needed to manage the Bristol Bay salmon fishery in FY 05 dollars totals about $1.7 million, not much different than the Governors total request but it should be comprised of $200,000 or less of test fish funding (Table 9) and $1,500,000 or more of general funds.

I recommend that ADF&G ensure that at least $1,500,000 of general funds be allocated for stock assessment and fishery management of Bristol Bay salmon in FY 05 and that at least this level of continuation funding be used over the next several years for support of the fishery management program for Bristol Bay salmon. To do so may require the movement of about $250,000 of general funds from other Divisional activities in FY 05.

Table 9.–Basic program needed by the Commercial Fisheries Division in FY 05 dollars to adequately manage Bristol Bay salmon.

Project/Activity	Approximate Funding Level Needed	Appropriate Funding Source	In FY 05 Governors Request
Kvichak Tower	$35,000	G.F.	Yes
Naknek Tower	$35,000	G.F.	Yes
Branch Tower	$35,000	G.F.	No
Egegik Tower	$35,000	G.F.	Yes
Ugashik Tower	$35,000	G.F.	Yes
Wood Tower	$35,000	G.F.	Yes
Nuyakuk Tower	$35,000	G.F.	No
Nushagak Sonar	$90,000	G.F.	Yes
Igushik Tower	$35,000	G.F.	Yes
Togiak Tower	$35,000	G.F.	Yes
Bristol Bay Research [a]	$180,000	G.F.	Yes
Catch Sampling	$75,000	G.F.	No[b]
Kvichak Test Fish	$30,000	Test Fish Fund	Yes
Egegik Test Fish	$30,000	Test Fish Fund	Yes
Ugashik Test Fish	$30,000	Test Fish Fund	Yes
Igushik Test Fish	$30,000	Test Fish Fund	Yes
District Test Fishing	$50,000	Test Fish Fund	Yes
Port Moller Test Fish	$30,000	Test Fish Fund	Yes
Port Moller General Fund	$90,000	G.F.	No[c]
Fishery Monitoring, Eastside	$100,000	G.F.	Yes
Fishery Monitoring, Westside	$50,000	G.F.	Yes
Program Management, Eastside [d]	$250,000	G.F.	Yes
Program Management, Westside [e]	$350,000	G.F.	Yes
TOTAL: General Fund	$1,500,000	+ $254,600	
TOTAL: Test Fish Fund	$200,000	- $272,900	
TOTAL: ALL FUNDING	$1,700,000	- $18,300	

Note: The budget above includes 8 permanent full time (PFT) positions as described below. This level of permanent fulltime positions is about the same as the level in place from the mid-1970s through the early 1990s and represents no change from the FY 05 Governors request.

[a] Includes the cost of two PFT research fishery biologists for roughly $140,000; operational expenses ($40,000) cover supervision of field programs, analysis and reporting of brood tables and pre-season forecasts.

[b] The catch sampling program is included in the FY 05 budget request, but funded with test fish funding; it would be appropriate to change funding source to general funds.

[c] The Port Moller project is included in the FY 05 budget request, but only for $30,000, or roughly the amount of funds obtained from selling the fish caught during the operation of the project leaving ADF&G in a position each year wherein additional funding has to be obtained from other funding sources.

[d] Includes the cost of two PFT management fishery biologists for roughly $190,000 that are directly responsible for management of salmon fisheries in the eastern half of Bristol Bay; operational expenses of about $60,000 for office support.

[e] Includes the cost of two PFT management fishery biologists for roughly $160,000 that are directly responsible for management of salmon fisheries in the western half of Bristol Bay, one PFT position for office support ($60,000) and one PFT maintenance position ($80,000) for repair and upkeep of offices, camps, and equipment; operational expenses of about $50,000.

ADDITIONAL PROGRAM NEEDS FOR BRISTOL BAY SALMON MANAGEMENT

While the level of funding identified above would provide adequate fiscal support for the very basic stock assessment program needed for management of the Bristol Bay salmon fishery, it is absolutely a "no frills" approach. Under this approach for instance, no funding would be used to enumerate smolt and hence gain an improved ability to forecast sockeye salmon runs. The ability of ADF&G to set escapement goals intended to maximize freshwater production of sockeye salmon smolt does not exist under this very basic funding approach. In other areas of the State of Alaska, smolt enumeration programs are annually implemented and funded. Bristol Bay produces, on average, more than one half of all sockeye salmon harvested in the State of Alaska (Table 1). Fiscal limitations reached the point where ADF&G could not support such efforts in Bristol Bay, yet such activities are ongoing in other areas where the potential benefits from such stock assessment activities are far less than is the case in Bristol Bay. Annual costs for a functional smolt enumeration program for Bristol Bay sockeye salmon would likely cost about $250,000 per year (about $50,000 each for the Kvichak, Naknek, Egegik, Ugashik, and Wood rivers).

Under the very basic funding approach for Bristol Bay salmon, no funding would be available to improve catch allocations to stock of origin for sockeye salmon. This represents another disconnect when one looks at the overall stock assessment program for salmon in the State of Alaska. Significant amounts of money are spent in many salmon fisheries in the State of Alaska to document stock of origin while such work in Bristol Bay has reverted to methodologies used over five decades ago before Alaska even claimed Statehood. Moving beyond the very crude catch allocation methodologies and utilizing scientifically available modern techniques has the potential to significantly alter the understanding of productivity and sustainability of the various Bristol Bay salmon stocks. Likely annual costs for a scientifically developed, genetic based stock of origin catch allocation program for Bristol Bay sockeye salmon would be in the range of about $200,000–$300,000 (8,000–10,000 samples per year). If such a program were fully implemented and fiscally supported over the long-run in Bristol Bay, improvements in the ability of ADF&G to provide pre-season forecasts would be made and improvements in the definition of appropriate escapement goals for sockeye salmon populations would be made. Under the basic program, progress would not be made to improve management capability for Chinook and coho salmon, high value species for which current fishery management in Bristol Bay remains rudimentary. Other fishery management areas in the State of Alaska spend $100,000s on stock assessments for coho and Chinook salmon stocks that historically and currently support substantially smaller fisheries for these species than already occurs in Bristol Bay. Improved information for these species would likely result in ADF&G being able to provide extended fishing seasons with higher average yields, but stock assessment efforts would have to be maintained across time. While efforts have been made in Bristol Bay to improve understanding of the escapement needs and productivity of Chinook and coho salmon, these efforts have been sporadic and ADF&G has been unable to continue funding these efforts through a sufficiently long period of time. A continuing level of funding on the order of $250,000 to $500,000 for improvement of stock assessment and fishery management of Chinook and coho salmon in Bristol Bay is fully justifiable.

Under the funding level described in Table 9, the ability of ADF&G to improve salmon management in Bristol Bay through use of current technological improvements in fishery models would be limited. The ability of ADF&G to manage Bristol Bay salmon fisheries would be the largely the same as has occurred over the past decade or so. Current information technology is such that with appropriate development, management models and tools could be developed that would allow ADF&G fishery management staff the ability to maximize economic value of salmon surplus to reproductive needs rather than continuing the more simple practice of the several past decades of trying to meet or exceed all escapement goals for all component stocks in each district, regardless of the current and future cost to

the salmon fishing industry. Such progress is especially important given that price per pound for salmon harvested in Alaskan fisheries is at low levels due to the marketing of pen raised salmon.

Such added funding could represent a major improvement in fishery management in fishing districts like the Nushagak District where daily management decisions during the peak of the season effect four relatively discrete stocks of sockeye salmon, a stock of chum salmon, and often at least the tails of the runs for Chinook, pink, and coho salmon. Modeling to take into account status of all runs, value by species, industry capacity, and best practices from an industry standpoint could all be utilized together with current available technology to assist fishery managers in making "best possible" decisions for current and future runs as fishing periods and areas are defined. Although difficult to describe, these types of quantitative tools could be used to greatly improve economic benefits from the common property fisheries of Bristol Bay, but development will cost monies that to date have not been allocated nor used to assist with Bristol Bay salmon fishery management. Likely costs to implement such work in Bristol Bay are on the order of $200,000 per year. Such types of work are ongoing in other salmon fisheries in Alaska and are fully justifiable in Bristol Bay.

The very basic stock assessment outlined in Table 9 totals about $1.5 million in general funds per year, but the kinds of stock assessment activities that are commonplace in many of Alaska's other salmon fisheries, but, no longer part of the Bristol Bay salmon program would probably total about another one million dollars of general funds per year. If the Bristol Bay program was supported with about $2.5 million, it would be on par with the kind of program in place and planned for long-term implementation in the early 1980s; and, on par with many of the other salmon fishery management programs in place in Alaska at the current time. While I will not recommend a reallocation of another $1 million in general funds into the Bristol Bay salmon program at the current time (above and beyond my earlier recommendation to move about $250,000 of additional general funds into the Bristol Bay salmon program), I will point out that such a reallocation of current Divisional general funds into the Bristol Bay program is probably fully justifiable.

It seems unlikely that $1,000,000 in "new" general fund support can be garnered for stock assessment and management of the Bristol Bay salmon fishery. As a result, I suggest that the Commercial Fishery Division of ADF&G work to incorporate the important elements discussed above into the annual stock assessment program for Bristol Bay through a cooperative and collaborative manner.

One very worthwhile effort would be for ADF&G to work more closely but with a long-term collaborative view with the Bristol Bay Science and Research Institute (BBSRI). The BBSRI was incorporated in 1998 and its primary goal is:

To undertake scientific, educational and charitable projects to facilitate a greater understanding of the marine environment and fisheries resources of the Bristol Bay region of Alaska and to pursue other scientific, educational and charitable projects that will foster the economic health and vitality of the region and its inhabitants.

The Bristol Bay Economic Development Corporation (BBEDC) formed the BBSRI in 1998 and currently provides the bulk of the Institute's funding with an annual capital contribution. BBEDC is one of six organizations within the Community Development Quota (CDQ) program. The CDQ program is a federal program that allocates a portion of the total-allowable-catch for all federally managed Aleutian Island and Bering Sea groundfish species to eligible communities in western Alaska. BBEDC was organized in 1992 as a private non-profit corporation and represents seventeen communities that surround Bristol Bay. The purpose of the BBEDC is to:

Promote economic growth and opportunities for residents of its member communities through sustainable use of the Bering Sea resources.

The Bristol Bay commercial salmon fishery is a major Bering Sea resource, critically important to member BBEDC communities. Over the past few years the BBSRI has actively stepped forward and positively assisted ADF&G by providing short-term funding and staff for various salmon stock assessment activities in Bristol Bay. However,

doing so has been awkward for both organizations because of the piecemeal approach which has largely been a reactive response to reductions in ADF&G funding support for the Bristol Bay salmon fishery management program.

I recommend that ADF&G and BBSRI enter into some long-term and relatively stable arrangements wherein BBSRI takes on the leadership role of one or more of the long-term stock assessment and fishery management improvement activities that are unlikely to be fiscally supported by the State of Alaska. The following are examples of the long-term cooperative and collaborative approach I recommend.

Bristol Bay Smolt Program. The BBSRI could be requested to annually provide adequate operational funds to implement the annual smolt enumeration program that ADF&G has lost due to budget cuts over the past several years. No funding is included in the Governors FY 05 budget for smolt work in Bristol Bay. In 2004, ADF&G only operated the Kvichak smolt project. It is important to revitalize the Bristol Bay smolt program and again enumerate smolt in the Ugashik, Egegik, Naknek, and Wood Rivers and important to continue and technically improve the smolt enumeration efforts for the Kvichak stock of sockeye salmon. ADF&G could provide the equipment used in the past for this work, share our camp facilities and ADF&G staff biologists could assist the BBSRI staff to the extent needed to promote scientifically sound smolt enumeration estimates for major sockeye salmon producing systems. BBSRI staff could lead this overall cooperative and collaborative effort and it would represent a major fishery science stock assessment effort that the Institute would be responsible for and carry into the foreseeable future.

Bristol Bay Stock Composition. BBSRI already provides technicians to implement the Bristol Bay catch sampling program. In 2004, these BBSRI catch samplers will archive tissue samples collected from mixed stock sockeye salmon fisheries of Bristol Bay. ADF&G technical staff could continue to develop the genetic baseline for sockeye salmon. ADF&G geneticists anticipate being in a position to analyze tissue samples from mixed stock fisheries in the next year or two to scientifically determine stock of origin, provided funding support to do so is secured. Through a collaborative effort, the BBSRI and ADF&G could seek additional monetary sources to augment funding that both groups already contribute to this overall research effort. In FY 04, ADF&G provided Fish and Game Funds for this research effort. Efforts within ADF&G to obtain additional Fish and Game funding should take place. Development of additional sockeye salmon genetic markers is ongoing and much of the planned activity for this type of work is taking place in other parts of Alaska with various soft money contracts. However, as these markers are identified, they can be utilized to improve the ability to identify Bristol Bay salmon stocks and used within the Bay for both improved stock of origin catch composition estimates and for targeted stock directed fishery management purposes. With assistance from the BBSRI, other sources of funding might be identified to strengthen and support this important stock assessment effort.

Chinook and Coho Stock Assessment. BBSRI has provided funding for extensions of escapement enumeration efforts associated with the Nushagak sonar project to facilitate improved stock assessments for coho and Chinook salmon. A comprehensive plan for improving stock assessments for coho and Chinook could be developed by staff of BBSRI working with the Division of Commercial Fisheries and the Division of Sport Fish of the ADF&G. Through improved planning, the roles of all three organizations, and perhaps other organizations such as Federal agencies could be focused with an eye toward the eventual development of a comprehensive stock assessment program for Bristol Bay coho and Chinook salmon through a multi-agency approach. Staff of the Division of Commercial Fisheries should strive to work with these other organizations to improve management capability for these species for the benefit of the users of the Bristol Bay salmon resource and the economic well being of Bristol Bay and Alaska in general.

Development of Fishery Models: Several staff employed by ADF&G and the BBSRI have the technical ability to develop improved fishery management models that have the potential to increase the exvessel value of the salmon harvests

in Bristol Bay. However, funding and allocation of the time for key staff members to complete such work is needed to develop these types of quantitative tools. Collaboration to request and hopefully secure soft money funding to initiate work on these types of important activities should take place. It is in the interest of both the BBSRI and the State of Alaska to increase the economic value of the Bristol Bay salmon harvests. The relatively high quality and long term data base associated with Bristol Bay salmon lends itself nicely to development of these types of fishery management tools. Another major issue is management of the Kvichak stock of sockeye salmon in the long term. Quantitative work is needed to provide management guidance concerning whether or not to manage for cyclic production. This issue has large potential costs and benefits in both the short-term and long-term to Bristol Bay fishermen, industry, and the State economy. Quantitative fishery management modeling that takes into account economic costs and benefits is needed for policy decisions on this matter. This question, like several others associated with the Bristol Bay salmon fishery would benefit greatly from serious quantitative fishery modeling.